

IN THE CLAIMS

What is claimed is:

- 1 1. A semiconductor device, comprising:
  - 2 a wiring structure in which an upper surface of a wiring made of a
  - 3 copper containing film is covered with an insulation film, wherein a barrier
  - 4 film is formed covering the upper surface of the wiring and between the
  - 5 wiring and a cap film for preventing copper diffusion.
  
- 1 2. The semiconductor device of claim 1, wherein:
  - 2 the barrier film is an exposure prevention film which prevents the
  - 3 wiring from being exposed to a film forming gas for the cap film.
  
- 1 3. The semiconductor device of claim 1, wherein:
  - 2 the cap film includes an SiCN film.
  
- 1 4. The semiconductor device of claim 3, wherein:
  - 2 the SiCN film is a film formed with a trimethylsilane gas, NH<sub>3</sub> gas,
  - 3 and a third gas, the third gas being selected from the group consisting of
  - 4 helium gas (He), nitrogen gas (N<sub>2</sub>), and argon gas (Ar).
  
- 1 5. The semiconductor device of claim 1, wherein:
  - 2 the barrier film is a film formed without using NH<sub>3</sub> gas.

1       6.     The semiconductor device of claim 5, wherein:

2                          the barrier film includes a SiC film.

1       7.     The semiconductor device of claim 1, further including:

2                          a multilayer wiring structure including a plurality of wiring layers  
3                          made of a copper containing film, with each wiring layer separated by a  
4                          respective interlayer insulation film.

1       8.     A method of producing a semiconductor device having a wiring structure in which an  
2                          upper surface of a wiring made of copper or a copper alloy is covered with an insulation film,  
3                          comprising the step of:

4                          forming a cap film, for prevention of copper diffusion, between the  
5                          wiring and the insulation film, and over a barrier film covering the upper  
6                          surface of the wiring.

1       9.     The method of producing the semiconductor device of claim 8, further including:

2                          a step of forming the barrier film without using a NH<sub>3</sub> gas after the  
3                          wiring film is formed.

1       10.    The method of producing the semiconductor device of claim 8, wherein:

2                          the barrier film includes an SiC film.

1       11.    The method of producing the semiconductor device of claim 8, wherein:

2           the step of forming the cap film includes using a trimethylsilane gas,  
3           NH<sub>3</sub> gas, and third gas after the barrier film is formed, the third gas being  
4           selected from the group consisting of helium gas (He), nitrogen gas (N<sub>2</sub>), and  
5           argon gas (Ar).

1   **12.**   The method of producing the semiconductor device of claim 11, wherein:  
2           the cap film is formed by introducing the NH<sub>3</sub> gas after the barrier film  
3           is formed by using the trimethylsilane gas and the third gas.

1   **13.**   The method of producing the semiconductor device of claim 11, wherein:  
2           the cap film includes a SiCN film.

1   **14.**   The method of producing the semiconductor device of claim 8, wherein the barrier  
2           film and the cap film are formed after the wiring is formed and further including the steps of:  
3           a series of processes for forming layers of wirings, each layer of  
4           wiring covered by an interlayer insulation film and including a step of forming  
5           a cap film, for prevention of copper diffusion, over a barrier film covering an  
6           upper surface of the layer of wiring.

1   **15.**   A method of producing a semiconductor device, including the steps of:  
2           forming a first wiring layer made of a copper containing film within a  
3           first interlayer insulation film;  
4           forming a first barrier film over an upper surface of the first wiring

5                   layer;

6                   forming a first cap film for preventing copper diffusion over the first

7                   barrier film; and

8                   forming a second interlayer insulation film over the first cap film.

1   **16.**   The method of producing the semiconductor device of claim 15, wherein:

2                   the step of forming the first barrier film does not include using a NH<sub>3</sub>

3                   gas.

1   **17.**   The method of producing the semiconductor device of claim 15, wherein:

2                   the first barrier film includes a SiC film; and

3                   the first cap film includes a SiCN film.

1   **18.**   The method of producing the semiconductor device of claim 15, wherein:

2                   the step of forming the first cap film includes using a trimethylsilane

3                   gas, NH<sub>3</sub> gas, and a third gas after the first barrier film is formed, the third gas

4                   being selected from the group consisting of helium gas (He), nitrogen gas

5                   (N<sub>2</sub>), and argon gas (Ar).

1   **19.**   The method of producing the semiconductor device of claim 18, wherein:

2                   the first cap film is formed by introducing the NH<sub>3</sub> gas after the first

3                   barrier film is formed by using the trimethylsilane gas and the third gas.

1      20.     The method of producing the semiconductor device of claim 15, further including the  
2     steps of:

3               forming a second wiring layer made of a copper containing film within

4               a third interlayer insulation film over the second interlayer insulation film;

5               forming a second barrier film over an upper surface of the second  
6     wiring layer; and

7               forming a second cap film for preventing copper diffusion over the  
8     second barrier film.